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Occupational Health in Chilean Copper Mine Workers: A Scoping Review of Literature (2008-2019)

Salud ocupacional en trabajadores mineros del cobre en Chile: una revisión exploratoria de literatura (2008-2019)

JOSÉ MATAMALA PIZARRO¹, FRANCISCO AGUAYO FUENZALIDA²,
PAULA ASCORRA COSTA³, ELISA ANSOLEAGA MORENO⁴

¹ Pontificia Universidad Católica de Valparaíso. Programa Doctorado en Psicología. Dirección Avda. El Bosque 1290, Viña del Mar. Orcid: <https://orcid.org/0000-0003-1369-4219>

² Pontificia Universidad Católica de Valparaíso. Programa Doctorado en Psicología. Dirección Avda. El Bosque 1290, Viña del Mar. Orcid: <https://orcid.org/0000-0003-4113-952X>

³ Pontificia Universidad Católica de Valparaíso. Programa Doctorado en Psicología. Dirección Avda. El Bosque 1290, Viña del Mar. Orcid: <https://orcid.org/0000-0001-9449-8273>

⁴ Universidad Diego Portales. Programa Estudios Psicosociales del Trabajo (PEPET). Programa Doctorado en Psicología. Dirección: Vergara 275, Santiago de Chile. Orcid: <https://orcid.org/0000-0003-0182-0126>

Correspondencia: José Matamala Pizarro, Dirección: Avda. El Bosque 1290, Viña del Mar. Chile (Código postal: 234000). Número de teléfono: +569 91252578.
jose.matamala@pucv.cl

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ABSTRACT

Introduction: the present article presents the results of a literature review on the health of mine workers on the Chilean copper market. Objective: To depict the evidence produced regarding the diseases that affect the health of Chilean mine workers.

Method: A scoping review, indexed on scientific journals and other sources, for the 2008-2019 period, centered on the analysis of 20 documents that reported empirical results.

Results: The main physical conditions of copper mine workers were found to be problems related to high-altitude work, the inhalation of silica dust, and noise exposure; eating and musculoskeletal disorders, cardiovascular and respiratory disorders, accidents, and low back pain. Regarding mental health conditions, the following were highlighted: psychological demands, the impact on the sleep quality due to shift work, fatigue, anxiety, depression, violence on subcontractors, and worsening of life standards after relocation, due to silicosis.

Discussion: working in copper mine impacts the global health of workers, increasing the exposure to health conditions that increases the sense of suffering and worsens their quality of life.

Keywords: mining, occupational health, working conditions, occupational risks, occupational diseases, men's health.

RESUMEN

Introducción: El presente artículo expone los resultados de una revisión de literatura sobre la salud en trabajadores de la minería del cobre en Chile. Objetivo: Describir las evidencias producidas sobre las afecciones a la salud vinculadas al trabajo en la minería del cobre chileno.

Método: Scoping review de literatura indizada en revistas científicas y otras fuentes entre los años 2008 y 2019, centrada en el análisis de 20 documentos que reportaron resultados empíricos.

Resultados: Se halló que las principales evidencias en materia de afecciones en la salud física de los trabajadores de la minería del cobre fueron: problemas relacionados con el trabajo a gran altura, la aspiración de polvo de sílice y la exposición al ruido; las alteraciones en la alimentación, los trastornos musculoesqueléticos, problemas cardiovasculares y respiratorios, los accidentes, alteraciones de alimentación y dolores lumbares. En cuanto a los hallazgos de afecciones en la salud mental destacaron: alta demanda psicológica, incidencia de los turnos de trabajo en calidad de sueño, fatiga, ansiedad, depresión y violencia en subcontratados, empeoramiento de la calidad de vida tras la reubicación por silicosis.

Discusión: El trabajo en la minería del cobre impacta la salud global de los trabajadores, aumentando la exposición a afecciones que aumentan su sensación de sufrimiento y empeoran su calidad de vida.

Palabras claves: minería, salud laboral, condiciones de trabajo, riesgos ocupacionales, enfermedades ocupacionales, salud de los hombres.

The WHO (World Health Organization) (1) recognizes the need to develop actions that benefits the health of workers, like prevention and protection against risks and hazards, as well as promotion of workplace health.

This would allow for the workers to enjoy an adequate standard of life, without the workplace diminishing it. This is achieved with healthy work environments, ones that must provide physical, psychological, social, and organizational conditions that protect and promote health and safety (2). However, there are workplaces that imply a high risk for health and safety, which leads to workers living with a sense of suffering (3).

In Chile, copper mining is a market that exposes their workers to high risks to their health. Chile accounts for the world's largest copper reserves, and it is the major exporter of this raw material. In order to accomplish the copper production cycle, thousands of workers, between direct and indirect employees, perform in this market. The evidence indicates that they expose themselves to risks and hazards to their physical health, such as, temperature variations (4), cardiovascular disturbances because of work in high-altitude (5), fractures, injuries, falls, lacerations, and musculoskeletal disorders (6), respiratory diseases, like tuberculosis or silicosis (7), exposure to pollutants and toxic chemical agents (8), among others. Mental conditions include stress at work (9), caused by a shifts work system, tasks, and extensive commuting that lessens social relations and limits the emotional bond with family and friends; even so, it can affect relatives, as they witness the depressive symptoms of their partners (10). At the same time, shift work can affect the sleep-wake cycle (11); which increases the sense of distress that turns into anxiety and depression symptoms.

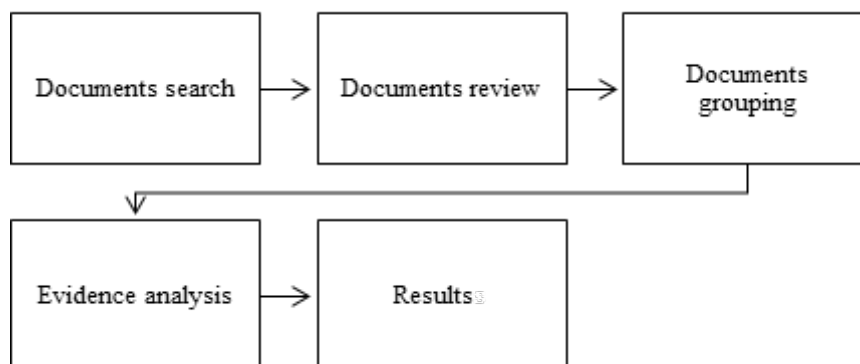
Due to the aforementioned, one action that can help to lessen occupational health risks and ensure more healthy surroundings in the national copper mining industry is the increase of knowledge about the group of diseases ailing the workers of this market. A contribution in this topic is this scoping review, which is the first one on the subject in Chile and Latin-America, a region where there

are also other countries, such as Peru, where copper mining is important for national development. The information order and the available evidence can help as much to the stimulation of further scientific research at both the continental and national level, as well to the establishment of policies oriented at the prevention of risks and hazards in this area, something useful for directing interventions and actions that benefit the prevention of diseases and promotes safety at the workplace.

METHODOLOGY

A scoping review of literature, indexed in scientific journals and other sources. Published documents from 2008 to 2019, about worker's health at Chilean copper mines. The aim consisted of depicting the evidence produced on the diseases of copper mine work that affect the health of their workers.

The review procedure consisted of five phases (see figure 1). In the first one, articles were searched on the WOS, SCOPUS, SCIELO, PubMed, and BVS databases. These databases were considered given that they are the most used in social and health sciences areas for the publication of articles related to the subject. In this research, only English keywords were considered, which were: "health and copper workers"; "health and miners"; "occupational health and miners", "occupational risk and miners"; "safety and miners"; "health and copper mining"; "health and copper miners"; "occupational health and copper workers"; "workplace health and copper workers"; "occupational risk and copper workers"; "safety and copper workers". In all searches, the "Chile" filter was applied. In total, 402 articles that could be included in this review were found.



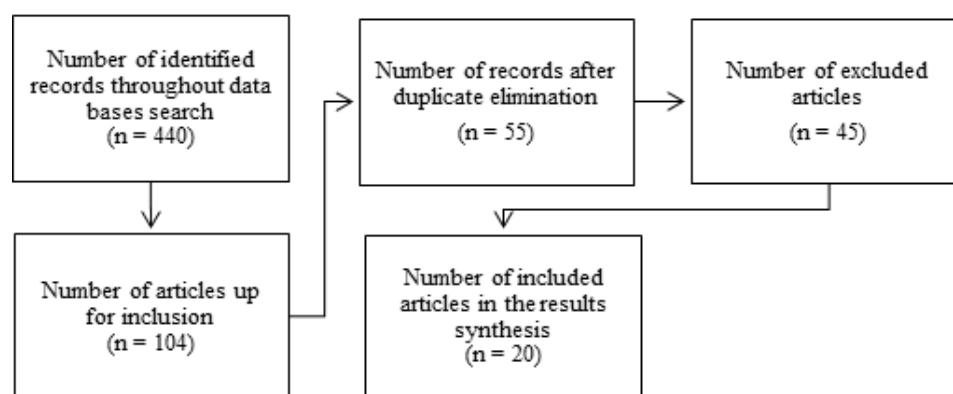
Source: own elaboration (2019).

Figure 1. Review procedure and results presentation

Furthermore, documents were searched in the virtual catalogs of the ministries and public agencies related to the subject in the country, such as the Geology and Mining Service (SERNAGEOMIN), the Labor Directorate (DT), the Ministry of Health (MINSAL) and the Superintendence of Social Security (SUSESO). The Spanish words “mineros” and “minería” were used in these search engines. Thus, 38 documents that could be included were found.

In the second phase, titles, abstracts, and introductions were read and then, the complete documents. Those who met the following criteria were included in the review: they reported empirical results of research about the review subject; they were published within the selected time interval (2008-2019). This interval was chosen, as it was interesting to depict the evidence produced after the entry into force of Law No. 20.123, which regularized outsourced work in Chile, a system that has been widely questioned by copper mine workers because it poses negative impacts on occupational health and safety.

Finally, the last inclusion criteria were that they had to be primary articles written in English or Spanish, and they were published in the previously indicated databases. The exclusion criteria were related to non-empirical articles (literature reviews, theoretical and methodological), those that specialized on health in miners in industries different to copper, those that were made before the research period, those that were written in languages other than those selected, and, finally, those that they were not fully available for reading. Figure 2 summarizes the search, inclusion, and exclusion procedure for the found articles.



Source: own elaboration (2019).

Figure 2. Number of included and excluded articles in this review

The documents that were included on this review are detailed on table 1. In the third phase, the documents were divided and grouped regarding their allusion to physical and mental health. Thus, the first group was formed by the evidence related to physical conditions, while the second group by the evidence related to mental conditions (see table 2).

Table 2. Summary of evidence-based review about health diseases at copper mines in Chile (2008-2019)

Documents grouping	
Evidence-based physical diseases review	Evidence-based mental diseases review
Sensory overload	Cognitive fatigue
Cervical injuries	Shift work who impacts the quality of life and job satisfaction.
Extreme temperatures	Disturbance of sleep-waking cycle.
Cardiovascular issues	Disturbance of quality of life due to relocation after silicosis diagnosis.
Arsenic exposure- Increase risk of cancer	Depressive symptoms, high job demand, distress
Musculoskeletal disorders	High job strain due to negative relations with the manager or bosses.
Injuries for heavy load, vibrations, and body postures demand.	Workplace harassment and anxiety in subcontracted workers.
Suspended dust	Women exposed to workplace violence as they enter the copper mining industry.
Annoying noise	Almost one 1/3 of workers are exposed to high psychosocial risks at work.
Exposition to dangerous chemical and pollutant agents	
Risk of falls, entrapment, and electric failures	
Acute Mountain Sickness – hypobaric hypoxia	
Fatal and non-fatal accidents	
Respiratory conditions- silicosis	
Disturbances in eating habits-overweight-lack of physical activity	
Low back pain syndrome.	

Source: own elaboration (2019).

To ensure the correct grouping, suitability was discussed. The data was extracted by the research team, paying attention to the name of the article, indexed journals or databases, year of publication, method, design, participants, and results regarding physical and/or mental health.

In the fourth phase, an analysis of the empirical evidence referred to in each registration was carried out. This allowed for the presentation of results according to the different diseases reported on both groupings.

Finally, on the fifth phase, the main results of the review were clearly stated, and then, discussed in relation to the existent literature on the subject.

Results

75% of the articles were found in scientific journals and/or web forums located in Chile. For the rest, similar percentages (5%), were found in journals from other countries, such as, the United States of America, Spain, Portugal, Korea, and Venezuela. 85% of the documents were redacted in Spanish, while the rest of them, in English (15%). The methodology that prevailed was the quantitative (80%), followed by the qualitative (10%), and mixed (10%). The research designs were mainly cross-sectional studies (50%), followed by longitudinal designs (25%), unspecified design (15%), and secondary databases review (10%). The samples were in general of good size, the study samples were mostly (60%) higher than 100 participants, highlighting a major prevalence on the male inclusion in them, taking into account that 9 out of 10 workers in Chilean mining are men. 50% of the articles were focused on the study of the workers physical conditions, whereas 45% of them were done on mental conditions. Just one document (5%) tackled the subject in both dimensions. Next, each of the studies and documents about the groupings on table 2, with the purpose of facilitating their comprehension and deepening their analysis.

Table 1. Summary of reviewed documents

Authors	Year	Documents names	Documents summaries	Journal or database
Vera A, Carrasco C, Vane-gas J y Contreras J	2008	Fatiga Física y Fatiga Cognitiva en Trabajadores de la Minería que Laboran en Condiciones de Altitud Geográfica. Relación con el Mal Agudo de Montaña	Objectives: (a)To account for the relation between physical and cognitive fatigue, Acute Mountain Sickness, and different socio-labor and psychosocial factors. (b) To propose predictors of physical and cognitive fatigue. Method: Cross-Sectional quantitative study. Parti-cipants: 120 male workers, randomly selected.	Ciencia & Trabajo
Vera, A y Contreras G	2008	Importancia de los Trastornos del Sueño como Causa de Fatiga en Trabajadores Mineros en Chile	Objective: To Depict the frequency and types of sleep disorders found in mine workers in the North of Chile. Method: Cross-Sectional quantitative Study. Parti-cipants: 180 operators of a mining company ubicated between 1600 and 1900 meters above the sea level (m.a.s.l) in the Chilean North.	Ciencia & Trabajo

Continue...

Authors	Year	Documents names	Documents summaries	Journal or database
Zárate et al	2009	Influencia de la obesidad en los costos en salud y en el ausentismo laboral de causa médica en una cohorte de trabajadores	Objective: To determine the cost, in health and the workplace absenteeism, associated with obesity, using data at the individual level; as well evaluating the impact of some associated comorbidities (diabetes, arterial hypertension, and dyslipidemias) in order to back up the implementation of a prevention, research, and treatment program. Method: Longitudinal quantitative study. Participants: 4673 incorporated workers of a mining company after their mandatory occupational health test.	Revista Médica de Chile
Apud E y Meyer F.	2009	Criterios ergonómicos constructivos para un desarrollo sustentable orientado a mejorar la calidad de vida laboral	Objective: To highlight the mistakes that occur because anticipation ergonomic criteria designed to improve the adaptation process of workers. Also, to highlight the importance of using existing knowledge on anthropometric and physiological features of the workers in the incorporation of new technology, as well as in the amendment of the used work method. Method: Longitudinal quantitative study. Participants: 600 workers in private and state-owned mining companies, from 1998 to 2008. It includes work carried out in surface and underground mining, as well activities developed in elaboration plants.	Laboreal

Continue...

Authors	Year	Documents names	Documents summaries	Journal or database
Ansoleaga E y Toro J.	2010	Factores psicosociales laborales asociados a riesgo de sintomatología depresiva en trabajadores de una empresa minera	Objective: To determinate if there are different risks of depressive symptoms according to the level of exposition to psychosocial risk at work. Method: Cross-sectional quantitative study. Participants: random sample of 303 workers in a Chilean mining company.	Salud de los trabajadores
Solari G y Solari B.	2010	Identificación de variables relacionadas con la condición física para el control ergonómico de factores humanos vinculados con el dolor lumbar	Objective: To identify significant differences between physical health indicators and Low Back Pain Syndrome (LBPS) Method: Cross-sectional quantitative study. Participants: 40 male workers in a big mining company in the North of Chile.	Ciencia & Trabajo
Delgado et al	2011	Efectos en el tiempo de la reubicación laboral y la calidad de vida en trabajadores mineros con silicosis de la División Andina-Codelco	Objective: To determine the effects in work relocation time and quality of life of mine workers with a silicosis diagnosis of the Codelco Chile Andean division. Method: Longitudinal quantitative case study. Participants: The SF 36 questionnaires' was applied to five workers with a silicosis diagnosis, three months before relocation, and three months after. Measures were taken monthly.	Medicina y seguridad del trabajo

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Authors	Year	Documents names	Documents summaries	Journal or database
Carrasco C y Vega	2011	Una aproximación a las condiciones de trabajo en la gran minería de altura	Objective: To examine the lifestyle and work conditions of thousand meters above sea level workers who work at several. Method: cross-sectional mixed study. Participants: 21 questionnaires were applied to companies and 125 questionnaires, to workers (45 belonging to principal companies and 80 contracted/subcontracted)	Dirección del Trabajo
Sandoval P	2011	Percepción de trabajadores en sistemas de turno de 8 y 12 horas.	Objective: To contrast the perceptions of two workers group that faced the change of the shift work system from three per day to two per day (from eight hours shifts to twelve hours shifts). Method: Longitudinal quantitative study. Participants: the 8 hours shifts system accounted for 382 workers, equal to 59.8% of the reference population.	Ciencia & Trabajo
Lasso J, Carrasco X, Riveros, A y Bittner V	2011	Evaluación de la calidad del sueño en trabajadores de la gran minería de cobre en turnos de día y de noche	Objective: To assess, using polysomnography, the difference in architecture and respiratory pattern during daytime and nighttime sleep of Chilean big mining companies' workers. Method: Longitudinal quantitative study. Participants: 119 male workers, 32 years old on average.	Ciencia & Trabajo

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Authors	Year	Documents names	Documents summaries	Journal or database
Delgado et al	2012	The Experience of Miners Relocated to Alternative Positions due to Silicosis in the Andean of CODELCO, Chile, 2010	Objective: To understand the personal experiences of mine workers who were relocated due to silicosis in CODELCO Andean division. Method: qualitative case study. Participants: a case study of five company workers.	Safety and Health at work
Caichac A et al	2013	Intervención en alimentación y nutrición para mineros con factores de riesgo cardiovascular. Chile	Objective: To design an eating and nutrition intervention model for miners with cardiovascular risks factors, results-based on formative research, as the initial phase for the formulation of a social marketing program in public health for workers of the area. Method: Mixed study. Participants: 94 mine workers with cardiovascular risks.	Revista chilena de nutrición
Garrido L y Hunt G	2013	Exploring Work Organization and Stress in the Mining Industry in Chile	Objectives: (1) to assess what factors of a work organization based on roles and status influence work stress and; (2) to consider workers' positive and negative opinions of their jobs and how they could reflect role relationships as a source of stress or well-being. Method: Cross-sectional quantitative study. Participants: 451 workers of 4 mining cities in the North of Chile.	Ciencia & Trabajo

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Authors	Year	Documents names	Documents summaries	Journal or database
Gómez P, Hernández J y Méndez M	2014	Factores de Riesgo Psicosocial y Satisfacción Laboral en una Empresa Chilena del Área de la Minería	Objective: To identify the relation between psychosocial risk factors and job satisfaction in subcontracted workers of a mining company in Chile. Method: Cross-sectional quantitative study. Participants: SUSESO-ISTAS 21 Questionnaire and the Job Satisfaction Questionnaire S20/23, applied to a sample of 100 workers	Ciencia & Trabajo
Pérez J	2014	Distribución del riesgo psicosocial laboral en Chile	Objective: To categorize the economic activities in Chile by their level of psychosocial risk at work. Method: Quantitative Study. Participants: Secondary review of database ENETS 2009-2010	Revista chilena de salud pública
Galleguillos et al	2015	La silicosis: ¿un problema de salud pública prioritario para Chile?	Objective: To review, both national and international, updated information, with the aim of establishing if silicosis is a relevant health issue. Method: Quantitative study. Participants: Secondary review of statistics information, databases, and surveillance programs.	Revista chilena de enfermedades respiratorias

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Authors	Year	Documents names	Documents summaries	Journal or database
Cortés P	2016	Cultura Alimentaria de un Grupo de Mineros Operarios de Maquinaria Pesada: Una Aproximación Etnográfica	Objective: To describe and interpret the eating culture of a mine workers group, as well as their needs, interests, and perceptions about their health. Method: Qualitative study. Participants: five male operators of heavy machinery, hand-picked for convenience.	Ciencia & Trabajo
Servicio de Geología y Minería	2017	Anuario de la minería de Chile	Objective: To inform the national and international community of the statistics regarding the production of metallic minerals, rocks, and industrial minerals and energy resources, and the accident rate in mining, based on information reported by mining companies. Method: Cross-sectional quantitative study. Participants: review of databases about the accident rate of mining companies.	SERNAGEOMIN
Escuela Salud Pública, U de Chile	2017	Estudio de los efectos de la exposición intermitente a gran altitud sobre la salud de trabajadores de faenas mineras	Objective: To observe the variations in the prevalence of symptoms and signs of health events between the baseline evaluation of 2015, and at the one year follow-up. Method: Cross-sectional quantitative study. Participants: a cohort of 499 workers recruited in 2015 in 6 mining chores ubicated at 800 to 4400 m.a.s.l.	Superintendencia de Seguridad Social

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Authors	Year	Documents names	Documents summaries	Journal or database
Brito J et al	2018	Long-Term Intermittent Work at High Altitude: Right Heart Functional and Morphological Status and Associated Cardiometabolic Factors.	Objective: to evaluate the state of the right cardiac circuit, along with potentially associated metabolic variables, and distinctive responses after a long exposure to the latter condition. Method: Cross-sectional quantitative study. Participants: 120 miners who worked at an altitude of 4400-4800 meters for more than five years in 7x7 days shift work.	Frontiers in physiology

Source: own elaboration (2019).

Physical Diseases of Chilean Copper Miners Regarding physical diseases, Apud & Meyer (13) found that the main diseases in surface and underground mines were sensory overload (prolonged interaction with computational or radio systems), risks of cervical sprain injuries on truck and machinery operators, the exposure to radiant temperature, which increases the cardiovascular load, and, finally, unsafe actions caused by poorly designed and distributed spaces. Workers with chronic arsenic exposure increase lymphocyte damage and decrease control of antioxidant mechanisms, increasing the risk of cancer (14).

In another paper (15), Apud again mentioned that miners faced extreme temperatures, high workload, risks of injuries, and the development of musculoskeletal disorders. All these complications, according to the author, were because mining work implies the performance of heavy activities, such as the handling of machinery, extensive shifts, vibrations, and demanding postural loads.

The above was complemented with a third study done by Carrasco & Vega in the year 2011(16), where they interviewed representatives of this sector. In these interviews, the crushing operator pointed out the exposure to suspended dust and annoying noises; those from a copper cathode plant, to hazardous chemicals (sulfuric acid, solvents); those in the flotation area, to working outdoors; those in a process plant, to falls and electrical risks; those in underground mines, to the risk of being caught by landslides; and those in administration, at ergonomic risks.

On the other hand, the Farias' et al (17) study highlighted that working in high altitude implies the exposure to hypobaric hypoxia, which is chronified by variations on altitude caused by the shift systems, producing physical alterations, jeopardizing the ventilatory response, pulmonary-circulatory adjustments, and the cardiovascular response. Silva (18) referred to the Acute Mountain Sickness as being responsible for arrhythmic events; as well as the transitions between sea level and high altitude increasing cognitive alertness and drowsiness. The study done by the School of Public Health from "Universidad de Chile" (19) stated that the Acute Mountain Sickness has a more degrading incidence for high altitude workers, affecting their executive and cognitive functions, resulting in a greater disadjustment on the first day of each shift. On the aforementioned, it was also mentioned, in the study performed by Brito et al (20), where most of the participants suffered from mild to moderate Acute Mountain Sickness, it being most notorious in 38.3% of the cases at the end of the first day of the shift.

On the other side, it is known that Chilean mine workers are exposed to deadly and non-deadly threats (21). Considering the evidence about mining accident rates by National Service of Geology and Mining (SERNAGEOMIN) in Chile. Since 2009, the accident rates with death results have been considerably reduced, shifting from a 0.1% rate in 2009, to a 0.035% rate in 2017 (22). Something very similar has occurred regarding disabling work accidents. The non-fatal accident rates have also considerably diminished, going from a 3.5% rate in 2009 to a 1.66% rate in 2018. Nevertheless, mining accidents keep attracting great attention, since they cause the greatest number of lost days, on average, in Chile (36.9%) (23). The main explanatory causes of work accidents in copper mining were referred to as the lack of protection against risks; dangerous procedures or methods, non-existent warning signs, lack of fortification, and unplanned ground defects (24).

Research interest on chronic respiratory diseases have persisted. Thus, Galleguillos et al (25) quantified the rise of silicosis addressed in the healthcare services of Coquimbo and Santiago, pointing out that this pathology has increased the medical appointments in a 26.7%. These diseases often involve the relocation of workers to other fields, which modifies their lifestyle.

Other analyzed risks have been the alteration of eating habits and health conditions related to it. In the Solari & Solari study, it was indicated that the physical state of copper workers tends to decrease, due to the lack of physical activity and overweight, which lead to Low Back Pain Syndrome (26). In association to eating disturbances, negatives changes in habits are due to Psychoso-

cial Factors, such as anxiety, lack of family support and traditions, which increments the risk of cardiovascular pathologies (27). This means that, on weekends or rest days, barbeques, alcoholic drinks, fast food, and easy preparation meals are consumed frequently (28). This also relates to higher obesity rates, diabetes mellitus, and hypertension, which, according to Zarate et al (29), were strong predictors of work absenteeism and increase healthcare expenses on the participants workers.

Mental Diseases of Chilean Copper Miners

Regarding the mental health diseases, the Vera's et al (30) study indicated that physical and cognitive fatigue correlate favorably (30). The greater the feeling of physical fatigue, the greater the feeling of cognitive fatigue; with Acute Mountain Sickness having an important weight on it. The conditions associated to these sensations were the level of job satisfaction, workload, and the shift system. Negative variations in them led to an increase in the sensation of both fatigues.

On the other hand, it has been pointed out that breaks according to day or night shifts implies an alteration in the workers sleep cycles. In the night shifts and day rest, the sleep time is shorter, as well as the latency to fall asleep is higher (31). The sleep alteration in shifts work implies the worsening of sleep quality, which difficults the reparative function itself, a worse perception in workers with 12 hours shift, given that they fail to completely attenuate their feeling of tiredness (32). The shift system, besides its influence on sleep quality, also impacts the job and family life of workers, leading to higher phycological tiredness and unsatisfaction in 12 hours shifts (32). Sleep can be altered by altitude work, as referred to by Vera & Carrasco (33) in their study, where 44.1% of participants presented an altered oximetry, and in 55% of the cases, sleep disorders were observed, with almost 30% of total participants presenting this disease.

Meanwhile, the study by Delgado et al. (34) indicated that the relocation process implied a negative effect on general health perception and its emotional part, because the change of post cut the emotional connection with work colleagues. This was confirmed by a following study of Delgado et al (35), where it added that the waiting time before relocation is lived by workers with a feeling of uncertainty, meanwhile, after the change of field was done, the presence of sadness incremented, a negative assessment of themselves (feeling of uselessness), a lack of vitality, fatigue, and difficulties in bonding with new colleagues.

Regarding the psychosocial risks, a study done by Ansoleaga & Toro (36), in which 23% of participants showed symptoms of depression and mentioned that the high psychological demand increased by an 83% the risk of having such symptoms, while the psychological distress increased that same risk by four and a half times. As previously said, the Garrido & Hunt study (37) indicated that the effort-reward factors and the quality of the relationship with management are predictors for job strains, as subcontracted workers were exposed to higher anxiety. In this segment, the physical environment quality and the workload quantity are also predictors for dissatisfaction and work harassment. It is worth noting that violence at work is directed towards women (38), in order to chase them away. Added to it, Pérez (39) highlighted that 28.6% of men in mining, surveyed by the National Survey of Employment, Work and Health (ENETS) 2009-2010 scored high on the psychological risks at work, while a 30.4% of their female counterpart did, in the same category.

Finally, the study done by Gómez, Hernández y Méndez (40) determined that the crushing and risk prevention workers were exposed to higher psychological demands, as they were exposed to active work and to difficulties regarding the possibilities of skill development; meanwhile, operators were found to be more unsatisfied with their work.

DISCUSSION

The purpose of this study was to depict the research produced on the diseases of Chilean copper miners. For that reason, an scoping review of literature was undertaken.

The described physical health conditions of the workers are consistent with those mentioned in the national and international scientific literature on the subject. For example, workers were found at risk of developing respiratory diseases, cancer, and arsenic contact diseases, which is similar to the report on the main occupational diseases in the sector indicated in the systematic review done by Cabrera, Velásquez & Vrhovac (41)

It is also consistent with findings on exposure to silica dust research by Chen et al. (42) with Chinese mine workers. At the same time, it was found that workers are exposed to extreme temperatures, a result similar to that indicated in the narrative literature review done by Maurya et al (4).

Also, regarding the risk of accidents, entrapment, and falls of Chilean copper workers, findings are consistent with the results of the narrative review of literature (43) on mining work in India.

Finally, the evidence related to risks of musculoskeletal diseases and ergonomic risks in mining are consistent with the results of the National Survey of Employment, Work, Health and Quality of Life (44) (ENCLA), where it was noted that these alterations are recent in all Chilean economic items. That is also consistent with the results of a systematic literature review (6) of injuries and working days lost in US mines, where it was found that musculoskeletal disturbances were due to injuries, slips, and falls.

Considering the evidence found in this research about the workers mental health diseases, the results were also consistent with those reported in the national and international literature. To mention one, the evidence on anxiety, depression, and stress at work in Chilean copper workers is similar to those indicated in a study (12) conducted with Iranian copper miners.

On the other hand, the results indicated that subcontracted workers are exposed to violence at work, a fact that contributes to expanding on what Salas et al. (45) indicated: that 18% of copper mine workers recognized the existence or workplace violence. Additionally, the negative incidence in quality of life due to relocation by silicosis is also consistent with that described in a case analysis (46) of a miner from “El Teniente” in Chile.

Finally, the incidence of the shift work system on the quality of life in this review is alike to those indicated by Salinas & Roman (47), who added that women who have entered copper mining report extensive shifts as obstacles, since they put tension on the domestic and care work they perform. Simultaneously, findings that the Acute Mountain Sickness possess relations to pulmonary disease, overweight, and sleep apnea align with Penaloza (48).

Based on the above, it is possible to conclude that copper mining work affects the health of workers in different days. During the research work, it was observed that the risks and diseases hurt and degrades body attributes, leading miners to suffer effects on their health. The injuries, musculoskeletal disorders, alterations on the respiratory system impact their quality of life since they create disability and limit their possibilities for the development of new tasks and specialties. This urges us to assume that the repercussions not only refer to physical alterations; but also involve their mental health, as a physical health condition implies an increase in suffering. This is further reinforced because copper mining work implies a negative impact for the workers mental health; where the work risks and hazards end up harming them, increasing pathogenic suffering at work.

The aforesaid reinforces the need to develop effective measures to address and prevent risk work conditions in copper mining, considering that, in Chile, more than 228,000 workers are employed in that field. (24) In this sense, the recommendations contained in ILO convention 176 (49) regarding safety and health inside the mines, could be followed. Chile, unlike Peru, that ratified it in the year 2008, has not done so.

The challenge is to promote research on the physical and mental health of copper miners, allowing for a more integral comprehension of their suffering, as it is suggested in studies in the psychodynamics Clinic of work (50, 51) discipline, that considers the experiences of suffering at work as an integral shape –it does not separate psyche and soma–. Hence, it is understandable that all diseases felt corporally have their correlation with the psyche of what involves the mobilizations of unpleasant number of affections. In this way, the conditions of the physical health mentioned in this study, as the Acute Mountain Sickness, have negative impact in the workers mental health, as in the case of fatigue and depression.

As a last note, the limitations of this reviews are related the non-elimination of the publication, since it only worked with published research, either in scientific journals or technical reports. Another limitation of the study is that it was not possible to access other sources of information, such as healthcare records in mutual societies, family health centers, and others that provide direct services to the mining population. Finally, it should be noted that most of the studies reviewed worked with predominantly male samples, which urges research that adequately involves female miners.

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